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MANIPAL INSTITUTE OF TECHNOLOGY
Manipal University

**FIFTH SEMESTER B.TECH (E & C) DEGREE END SEMESTER EXAMINATION**
**NOV/DEC 2015**
**SUBJECT: COMPUTER VISION (ECE - 333)**

**TIME: 3 HOURS** **MAX. MARKS: 50**

**Instructions to candidates**
- Answer **ANY FIVE** full questions.
- Missing data may be suitably assumed.

1A. Given a 12 x 12 3-bit grayscale image I in which every pixel except the center point is zero and the center pixel is 7 (i.e. I(6,6)=7). Apply a uniform averaging filter of size 3 x 3 on this image. Clearly describe each step. Describe the difficulty faced at the boundary of the image while applying this filter. Suggest two possible solutions and discuss the advantages (if any) and disadvantages (if any) of each solution.

1B. Given an image corrupted with additive periodic noise. Assume that the noise can be approximated as a 2D sin function. Describe a filter to recover the original image without noise. Justify your answer. Describe the procedure to create a Gaussian Pyramid of N x N image.

1C. With the help of suitable diagram, derive the perspective projection equation.

(5+3+2)

2A. With the help of a suitable example, explain the non-maximum suppression and hysteresis thresholding algorithm. Explain one example/image where you would use these two algorithms.

2B. Describe the algorithm to compute Histogram of Oriented gradient features.

2C. Differentiate between HOG and SIFT features. Describe one application of HOG features.

(5+3+2)

3A. Describe the algorithm for agglomerative clustering and divisive clustering. Discuss the two difficulties of agglomerative and divisive clustering.

3B. State the mathematical expression for computing the first order and second order image gradient. Given an image strip consisting of 13 pixels (1-13) from a 3 bit grayscale image. The strip consists of a flat segment (1-3), a ramp (4-8) and an isolated point (11). Compute the first order and second order derivative for this image strip. Using the above image strip as an example, discuss the properties of first order and second order image gradient in the ramp and isolated point.

| Index -> | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Strip -> | 0 | 0 | 0 | 5 | 4 | 3 | 2 | 1 | 0 | 0 | 7 | 0 | 0 |

3C. Define a gray scale co-occurrence matrix used for texture representation. Given the following image patch calculate $C_{(1,2)}$, $C_{(2,2)}$ gray scale co-occurrence matrices.

| | | | |
|---|---|---|---|
| 1 | 1 | 0 | 0 |
| 1 | 1 | 0 | 1 |
| 2 | 1 | 1 | 1 |
| 2 | 2 | 2 | 2 |

(5+3+2)

4A. With the help of suitable example, describe in detail the different steps of Hough Transform algorithm for fitting a straight line. Discuss at least two difficulties of Hough Transform algorithm.

4B. Describe HSI color model. Clear state what each component (H, S and I) represents.

4C. State the epipolar constraint. Consequently, define the essential matrix.

(5+3+2)

5A. Given a training dataset $(x_1,y_1),....(x_N,y_N)$ consisting of $N$ points $(x_1,....x_N)$. Each point is assigned a class label which is denoted by 1 or -1. Let $y_i$ represents the class label. Show that in support vector machine for linearly separable data, the decision boundary is determined by minimizing $norm(w)^2$, subject to $y_i(wx_i + b) >= 1$, where $w,b$ are the parameters of the hyperplane. Compare support vector machine with a classifier where the class conditional densities are modelled with histogram.

5B. Define radial distortion. Describe the process of estimating the camera parameters in the presence of radial distortion.

5C. Given two image points $p$, $p'$ corresponding to a 3D scene point $P$. Suppose the image points $p$, $p'$ and camera projection matrix are known, and we wish to estimate 3D scene point $P$. Discuss two different approaches to calculate the 3D scene point $P$.

(5+3+2)

6A. In the topographical interpretation of the image used in watershed segmentation, list the three different types of points present in the image. Identify the points that we obtain using the watershed segmentation. Discuss the disadvantage of watershed algorithm for image segmentation. Suggest a possible solution to overcome this problem.

6B. Describe the algorithm for a $(k,l)$ nearest neighbor classification. List at least one difficulty in building this classifier

6C. Differentiate between class confusion matrix and Receiver Operating Curve (ROC).

(5+3+2)